HANDLING PEANUTS WITH BUCKET ELEVATORS
Rates of Conveying and Mechanical Damage

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HANDLING PEANUTS WITH BUCKET ELEVATORS
Rates of Conveying and Mechanical Damage

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SUMMARY

Spanish, Runner, and Virginia farmers stock peanuts were conveyed with two bucket elevators, one having 6- by 4-inch buckets (small-bucket elevator) and one having 9- by 5½-inch buckets (large-bucket elevator), to determine the rate of conveying in a range of belt speeds and with two bucket spacings on each elevator and to determine the mechanical damage to the peanuts.

At belt speeds from 140 to 380 feet per minute (f.p.m.) the small-bucket elevator with the buckets spaced every 4¼ inches on the belt conveyed Spanish peanuts at a rate of 4 to 6¾ tons per hour, and Runner peanuts at 5 to 8 tons per hour. Rates of conveying for the Virginia peanuts were slightly less. At belt speeds above 380 f.p.m. the rate of conveying for all types of peanuts decreased.

The maximum rate of conveying obtained with the small-bucket elevator was approximately the same with an 8½-inch bucket spacing as with the 4¼-inch bucket spacing. However, it was necessary to use a belt speed approximately 100 f.p.m. higher with the wider bucket spacing than with the closer bucket spacing to obtain the maximum conveying rate.

At belt speeds from 140 to 380 f.p.m. the large-bucket elevator with buckets spaced at 6 inches on the belt conveyed Spanish peanuts at a rate of 17½ to 21 tons per hour, and Runner peanuts at 15½ to 21 tons per hour. Rates of conveying for the Virginia peanuts were slightly less. At belt speeds above 380 f.p.m. the rate of conveying for all types of peanuts decreased.

For the large-bucket elevator the maximum conveying rate with a 12-inch bucket spacing was approximately the same as with the 6-inch bucket spacing. However, as with the small-bucket elevator, it was necessary to use a belt speed approximately 100 f.p.m. higher with the wider bucket spacing than with the closer bucket spacing to obtain the maximum conveying rate.

The bucket elevators caused only moderate damage to the peanuts. Generally, the Spanish peanuts were damaged the least, the Runner peanuts slightly more, and the Virginia peanuts the most. All three types of peanuts followed the same pattern in their sensitivity to a particular kind of damage. The least damage was always in split kernels, with loose shelled kernels (LSK) and cracked or broken pods next in order.

The small-bucket elevator caused slightly more damage than the large-bucket elevator. The greater damage was attributed to the smaller clearance between the buckets and casing in the small-bucket elevator. Frequently the larger pods, particularly with the Virginia peanuts, were caught and dragged along between the buckets and casing.

Most of the damage occurred with the closer bucket spacings and at belt speeds above 200 f.p.m. Belt speed was more critical than bucket spacing in causing damage, and approximately 60 percent of the total damage occurred at belt speeds above 200 f.p.m.

Bucket elevators are acceptable equipment for conveying farmers stock peanuts. The conveying rates were satisfactory, but they were affected by the type of peanut being conveyed and the foreign material in the peanuts. The tests showed that belt speeds and bucket spacings must be correlated to obtain optimum conveying rates.

INTRODUCTION

Peanut production in the United States has increased tremendously in the past few years because of improved varieties and production practices. However, the development of improved

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methods of drying, storing, and handling has not been as rapid, primarily because the economics of alternative methods has not been favorable. The economic situation is changing, and the costs of the old methods of handling and processing peanuts are becoming prohibitive. Plant operators are vitally interested in improved methods, techniques, and equipment that will lower operating costs and maintain product quality.

The feasibility of conveying Spanish, Runner, and Virginia farmers stock peanuts by bucket elevators was investigated in this study. Rates of conveying and damage to peanuts were determined. The study is part of a broad research project to develop improved methods, techniques, and equipment for handling peanuts at commercial storages.

BUCKET ELEVATORS AND CONVEYING METHODS

Farmers stock peanuts were unloaded by gravity flow from a truck onto a belt conveyor from which they were discharged into the boot of a bucket elevator having 6- by 4-inch buckets (hereafter referred to as small-bucket elevator). The elevator lifted the peanuts and discharged them into an overhead scale bin, where they were weighed and then discharged by gravity flow into the boot of a bucket elevator having 9- by 5½-inch buckets (hereafter referred to as large-bucket elevator). This elevator lifted the peanuts and discharged them into a spout, from which they flowed by gravity back into the truck. Gates were used to regulate peanut flow and thus maintain a uniform depth of peanuts in the elevator boot. The peanut depth in the boot permitted a maximum amount of peanuts to feed into the buckets as they passed through the loading section of the bucket elevator.

The elevators were of standard manufacture, with buckets mounted on the belt in the usual manner, but they were equipped with variable-speed drives to permit operation in a wide range of belt speeds. They were inspected periodically to insure proper belt tension and alinement, proper bucket shape, and proper operation.

Two bucket spacings were tested on each elevator. Buckets were spaced at 4¼- and 8½-inch centers on the small-bucket elevator and at 6- and 12-inch centers on the large-bucket elevator. Belt speeds were increased from 140 to 420 feet per minute (f.p.m.) in increments of approximately 40 f.p.m. at each bucket spacing. The lengths of the belts were measured, and the buckets on each belt were numbered. At each belt speed, the buckets passing the observation window (fig. 1) per unit of time were counted.

Three lots of peanuts were moved through each bucket elevator at each belt speed. Each time a lot of peanuts was conveyed, the average time required per belt revolution with full buckets was determined. Belt speeds were calculated by dividing the length of the belt by the average time required per revolution.

Actual and theoretical rates of conveying were obtained. The actual handling rates of each bucket elevator were determined by weighing each lot of peanuts and measuring the time required to move it through the elevator. The theoretical handling rate of each bucket elevator was considered to be the weight of peanuts that the elevator could convey per unit of time with the buckets full, but not mounded. The theoretical rate of handling was calculated by multiplying the number of buckets handled per unit of time by the weight of peanuts in each bucket.

A different lot of peanuts was used for each bucket spacing to prevent variation in quality

Figure 1.—Observation window installed in each bucket elevator casing permitted timing of belt revolutions and observation of bucket loading. Here peanuts are mounded in the buckets.

as a result of repeated conveying of the same lot of peanuts. Peanuts of the same type came from the same source. Before the peanuts of each type were divided into test lots, they were thoroughly mixed. To determine whether variations among lots existed, both a grade analysis and a density measurement were made on three samples from each test lot. In addition, samples from each test lot were analyzed for damage before the tests began. The densities of the Spanish, Runner, and Virginia peanuts were 20.5, 19.5, and 15 pounds per cubic foot, respectively. The moisture content of the three types of peanuts ranged from 7 to 8 percent.

Each time a lot of peanuts was conveyed, a sample was collected and analyzed for damage. The damage analysis consisted of the amount of split kernels, loose shelled kernels (LSK), and cracked or broken pods. To verify that samples were representative of test lots, 10 percent of the peanuts in each test lot was removed before handling, dyed green, and remixed with the lot. A sample collected from a lot was considered representative of the lot if 10 percent of the peanuts in the sample was green.

The amount of split kernels in a test lot was determined from a randomly collected 500-gram sample of peanuts shelled with the official grade peanut sample sheller. The split kernels were separated from the whole kernels and weighed.

The amount of LSK in a test lot was determined by collecting a random sample, separating the LSK from the sample, and weighing them. On several series of tests with the small-bucket elevator, an alternate method also was used to determine the amount of LSK in a test lot. This alternate method consisted of moving the lot of peanuts across a vibrating screen that separated the LSK from the remainder of the lot. Once the LSK were removed, they were weighed, and the percentage of LSK in the lot was computed.

The amount of cracked or broken pods in a test lot was determined by separating 300 grams of undyed peanuts from the lot, coloring them with a vegetable dye, and then hand shelling and examining the kernels and inside of the hulls for dye stains.

TEST RESULTS

Conveying Rates

The large-bucket elevator of course conveyed peanuts at the greater rate, but, considering each elevator individually, bucket spacing and belt speed were the most important factors determining conveying rate. These were not, however, the only factors. Theoretically, the closer bucket spacing and a belt speed of 200 f.p.m. should have given the same conveying rate as the wider bucket spacing and a belt speed of 400 f.p.m. The conveying rates were not in fact the same; other factors, such as type of peanuts, density, and foreign material in the peanuts, reduced bucket loading and thus conveying rate. Since the wider bucket spacing permitted much better loading, belt speed had only to be increased approximately 100 f.p.m. above that of the closer bucket spacing to obtain the same rate of conveying. The effect of belt speed on conveying rates is illustrated in figures 2 through 13. The conveying rates are given in tables 1 and 2.

TABLE 1.—Rates of conveying peanuts with small-bucket elevator

[Tons per hour]

Peanut type	Bucket spacing	
	4¼-inch	8½-inch
Spanish	4-6¾	3 -7½
Runner	5-8	3 -7¾
Virginia	4-5½	2½-6½

TABLE 2.—Rates of conveying peanuts with large-bucket elevator

[Tons per hour]

Peanut type	Bucket spacing	
	6-inch	12-inch
Spanish	17½-21	8½-20
Runner	15½-21	8 -18½
Virginia	9 -18	7½-17

An index of bucket loading was arbitrarily defined as the ratio of the actual rate of conveying to the theoretical rate of conveying. Except for the tests with Virginia peanuts, bucket spacings of 8½ inches on the small-bucket elevator and 12 inches on the large-bucket elevator resulted in an index greater than 1 over most of the belt-speed range. An index greater than 1 indicated that peanuts were mounded higher than the buckets (fig. 1). When bucket spacings of 4¼ inches with the small-bucket elevator and 6 inches with the large-bucket elevator were used, the index was less than 1 over most of the

belt-speed range for all types of peanuts conveyed, which indicated that the buckets were not being filled as they passed the loading position of the elevators.

Mechanical Damage

Neither bucket elevator caused extreme mechanical damage to any of the three types of peanuts. The Spanish and Runner peanuts were damaged slightly less than the Virginia type, but all three types were consistent in their sensitivity to a particular type of damage. The least damage was always in split kernels, with LSK and cracked or broken pods next in order.

The small-bucket elevator caused slightly more damage because there was less clearance between the buckets and the casing than in the large-bucket elevator. Frequently, the large pods that spilled from the buckets were caught and dragged along between the buckets and the casing. The Virginia peanuts, which had larger pods, showed more damage than the other two types, which had smaller pods. The clearance between the buckets and casing on the large-bucket elevator was sufficient to allow peanuts that fell from the buckets to fall back into the boot instead of being dragged between the buckets and casing.

The amount of a particular type of damage that occurred each time the peanuts were conveyed was so small that it could not be detected between consecutive samples. However, as the tests progressed, the damage accumulated and was much more evident when samples taken toward the end of the tests were compared with those taken at the beginning. Removing the LSK from the test lot of peanuts after each pass through the bucket elevator made possible a more precise determination of LSK damage than was possible by sampling.

The following discussion is confined to damage caused by the small-bucket elevator, but the data for the large-bucket elevator are also given. While the amount of damage sustained by the three types of peanuts varied, the trend, illustrated in the discussion by Spanish peanuts, was similar for all.

Split kernels

A bucket spacing of 4¼ inches caused slightly less split kernel damage than an 8½-inch spacing in Spanish peanuts conveyed with the small-bucket elevator (table 3). About 40 percent of the total split kernels occurred at belt speeds below 200 f.p.m.; approximately 60 percent occurred at belt speeds above 200 f.p.m. When the buckets were spaced at 8½ inches, there was little difference in the amount of split kernels that occurred at belt speeds above and below 200 f.p.m.

Only a minor increase in split kernels occurred each time the peanuts were moved through the elevator. The split kernels in the Spanish peanuts averaged 1.9 percent before the passes through the small-bucket elevator and 2.6 percent after being conveyed 12 times—a

TABLE 3.—Average percentage-point increase in split kernels per conveyance of three peanut types with small-bucket elevator

Test variation	Peanut type		
	Spanish	Runner	Virginia
Bucket spacing and belt speed:			
4¼-inch; below 200 f.p.m.	0.02	0.07	0.03
4¼-inch; above 200 f.p.m.	.06	.09	.08
8½-inch; below 200 f.p.m.	.05	.02	.02
8½-inch; above 200 f.p.m.	.06	.05	.17
Bucket spacing:[1]			
4¼-inch	.04	.08	.05
8½-inch	.05	.03	.09
Belt speed:[2]			
Below 200 f.p.m.	.03	.05	.02
Above 200 f.p.m.	.05	.08	.12

[1] Each percentage-point increase is the average obtained with the 2 belt-speed ranges at each bucket spacing.

[2] Each percentage-point increase is the average obtained with the 2 bucket spacings at the belt speeds given.

TABLE 4.—Average percentage-point increase in split kernels per conveyance of three peanut types with large-bucket elevator

Test variation	Peanut type		
	Spanish	Runner	Virginia
Bucket spacing and belt speed:			
6-inch; below 200 f.p.m.	0.03	0.04	0.04
6-inch; above 200 f.p.m.	.04	.06	.08
12-inch; below 200 f.p.m.	.03	.02	.03
12-inch; above 200 f.p.m.	.03	.03	.08
Bucket spacing:[1]			
6-inch	.03	.03	.07
12-inch	.03	.03	.05
Belt speed:[2]			
Below 200 f.p.m.	.03	.03	.03
Above 200 f.p.m.	.04	.05	.08

[1] Each percentage point increase is the average obtained with the 2 belt-speed ranges at each bucket spacing.

[2] Each percentage-point increase is the average obtained with the 2 bucket spacings at the belt speeds given.

total increase of 0.7 of a percentage point. Split kernels in Runner peanuts increased 0.9 of a percentage point after being conveyed 12 times; in the Virginia peanuts the increase was 1.5 percentage point.

Loose shelled kernels

A bucket spacing of 4¼ inches caused more than twice as many LSK as an 8½-inch spacing in Spanish peanuts conveyed with the small-bucket elevator (table 5). Approximately 59 percent of the total LSK at the 4¼-inch spacing occurred at belt speeds above 200 f.p.m. About 64 percent of the total LSK at the 8½-inch spacing occurred at belt speeds above 200 f.p.m. Disregarding the bucket spacing and combining the total LSK resulting at each of the belt-speed ranges, 60 percent of the LSK resulted from belt speeds about 200 f.p.m.

LSK increased each time the peanuts were conveyed under all test conditions. In Spanish peanuts LSK increased an average of 0.07 of a percentage point the first time they were conveyed and gradually increased to an average of 0.13 of a percentage point the 12th time they were conveyed. The total increase in LSK in Spanish peanuts was 1.2 percentage points during the 12 times they were conveyed. LSK in Runner peanuts increased 1.8 percentage points during the 12 times they were conveyed, and in Virginia peanuts, 2.2 percentage points.

TABLE 5.—Average percentage-point increase in loose shelled kernels per conveyance of three peanut types with small-bucket elevator

Test variation	Peanut type		
	Spanish	Runner	Virginia
Bucket spacings and belt speed:			
4¼-inch; below 200 f.p.m.	0.12	0.14	0.16
4¼-inch; above 200 f.p.m.	.17	.18	.17
8½-inch; below 200 f.p.m.	.04	.11	.16
8½-inch; above 200 f.p.m.	.07	.16	.24
Bucket spacing:[1]			
4¼-inch	.14	.16	.17
8½-inch	.06	.14	.20
Belt speed:[2]			
Below 200 f.p.m.	.08	.13	.16
Above 200 f.p.m.	.12	.17	.21

[1] Each percentage-point increase is the average obtained with the 2 belt-speed ranges at each bucket spacing.

[2] Each percentage-point increase is the average obtained with the 2 bucket spacings at the belt speeds given.

TABLE 6.—Average percentage-point increase in loose shelled kernels per conveyance of three peanut types with large-bucket elevator

Test variation	Peanut type		
	Spanish	Runner	Virginia
Bucket spacing and belt speed:			
6-inch; below 200 f.p.m.	0.09	0.06	0.06
6-inch; above 200 f.p.m.	.17	.14	.09
12-inch; below 200 f.p.m.	.02	.05	.02
12-inch; above 200 f.p.m.	.10	.11	.12
Bucket spacing:[1]			
6-inch	.13	.10	.08
12-inch	.06	.08	.04
Belt speed:[2]			
Below 200 f.p.m.	.05	.06	.05
Above 200 f.p.m.	.13	.12	.10

[1] Each percentage-point increase is the average obtained with the 2 belt-speed ranges at each bucket spacing.

[2] Each percentage-point increase is the average obtained with the 2 bucket spacings at the belt speeds given.

Cracked or broken pods

Cracked or broken pods increased more than any of the other damage indicators in all three types of peanuts. This type of damage does not directly affect milling yields, but does permit increased contamination of the peanuts by dirt, mold, and insects.

The small-bucket elevator cracked or broke twice as many Spanish peanut pods with the 4¼-inch bucket spacing as it did with the 8½-inch bucket spacing (table 7). With either spacing, most of the damage occurred at belt speeds above 200 f.p.m.

TABLE 7.—Average percentage-point increase in cracked or broken pods per conveyance of three peanut types with small-bucket elevator

Test variation	Peanut type		
	Spanish	Runner	Virginia
Bucket spacing and belt speed:			
4¼-inch; below 200 f.p.m.	0.66	0.33	0.62
4¼-inch; above 200 f.p.m.	1.30	.50	1.04
8½-inch; below 200 f.p.m.	.41	.62	.25
8½-inch; above 200 f.p.m.	.58	.80	1.08
Bucket spacing:[1]			
4¼-inch	1.00	.41	.80
8½-inch	.50	.70	.66
Belt speed:[2]			
Below 200 f.p.m.	.50	.48	.46
Above 200 f.p.m.	.96	.65	1.00

[1] Each percentage-point increase is the average obtained with the 2 belt-speed ranges at each bucket spacing.

[2] Each percentage-point increase is the average obtained with the 2 bucket spacings at the belt speeds given.

Average mechanical damage increases

The average increase in mechanical damage caused by the small-bucket elevator (table 8) was greatest in the Virginia peanuts, with the Spanish and Runner peanuts next in order. The quality of the peanuts undoubtedly had some effect on the amount of damage. No history of the peanuts was available, but the quality of the Spanish and Runner peanuts was considered good, and the quality of the Virginia peanuts was fair to average.

TABLE 8.—Average percentage-point increase in mechanical damage per conveyance of three peanut types with small-bucket elevator

Peanut type	Split kernels	Loose shelled kernels	Cracked or broken pods
Spanish	0.05	0.10	0.73
Runner	.06	.15	.56
Virginia	.07	.18	.75

TABLE 9.—Average percentage-point increase in mechanical damage per conveyance of three peanut types with large-bucket elevator

Peanut type	Split kernels	Loose shelled kernels
Spanish	0.03	0.09
Runner	.04	.09
Virginia	.06	.07

CONCLUSIONS

This study showed that a bucket elevator is acceptable equipment for conveying farmers stock peanuts. The rates of conveying were good, and apparently a particular bucket spacing was best for a particular belt speed. However, the best bucket spacing for a particular belt speed depended on the type of peanut being conveyed and the amount and length of the foreign material intermingled with the peanuts. Inasmuch as bucket spacing is not easily changed on a bucket elevator, a bucket spacing that will convey all the types and qualities of peanuts satisfactorily should be selected.

At a belt speed of 200 f.p.m. the index of bucket loading for all types of peanuts conveyed by the small-bucket elevator with a $4\frac{1}{4}$-inch bucket spacing averaged 0.7. Thus, a spacing of approximately 6 inches would have resulted in an index of 1, or full bucket loading, at a 200-f.p.m. belt speed. A similar analysis for the large-bucket elevator with a 6-inch bucket spacing and a belt speed of 200 f.p.m. indicated that full bucket loading could have been obtained with a 7-inch bucket spacing.

When selecting belt speeds and bucket spacings for conveying farmers stock peanuts, consideration should not be limited to obtaining the maximum rate of conveying. The mechanical damage that will be done to the peanuts at certain belt speeds and bucket spacings should also be considered. This study showed that belt speed was the most critical of the two factors and that less damage occurred at belt speeds below 200 f.p.m. than at belt speeds above 200 f.p.m. The 6-inch bucket spacing on the small-bucket elevator and the 7-inch spacing on the large-bucket elevator, discussed in the preceding paragraph, represent a compromise between the maximum rate of conveying and the potential mechanical damage. At a 200-f.p.m. belt speed, these spacings should give satisfactory performance in bucket elevator operation for most applications.

ACKNOWLEDGMENTS

Appreciation is expressed to William G. Ferguson, engineering technician, for assisting with the testing and collection of data, and to Larry S. Creel, agricultural commodity grader, for analyzing the samples for damage. Both are with the National Peanut Research Laboratory, Dawson, Ga.

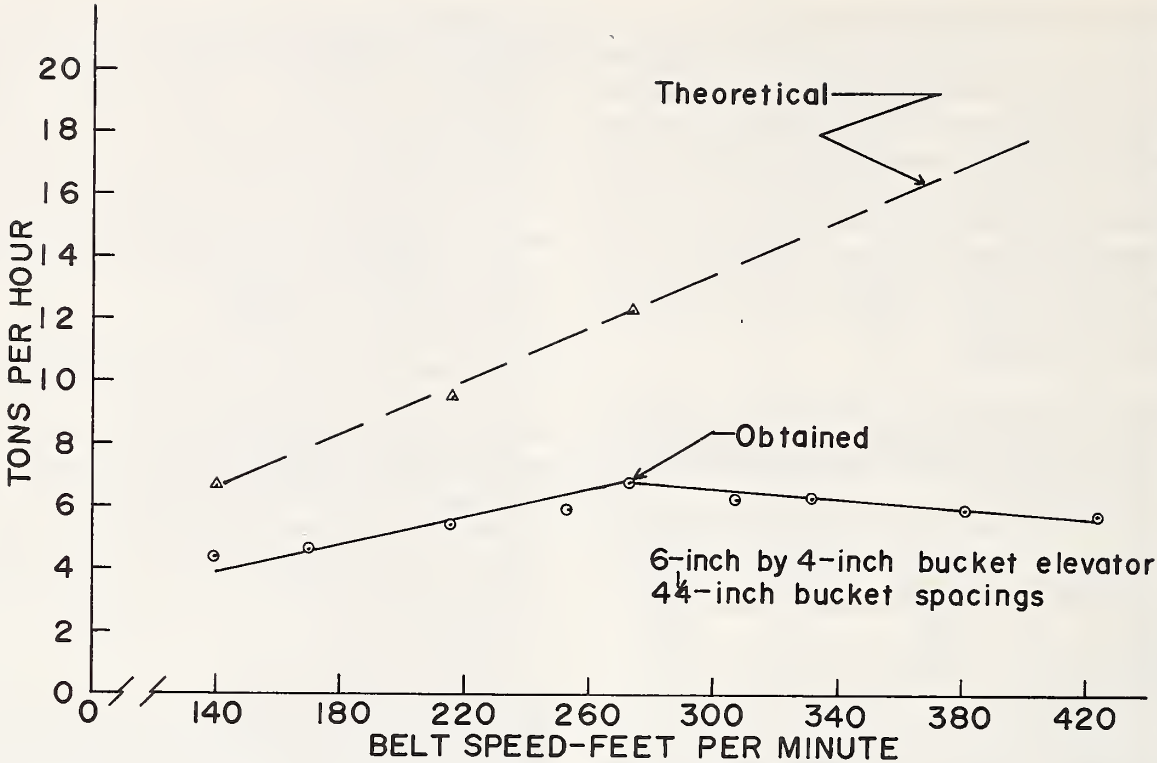

Figure 2.—Effect of belt speed on rate of conveying Spanish peanuts with small-bucket elevator, 4¼-inch bucket spacing.

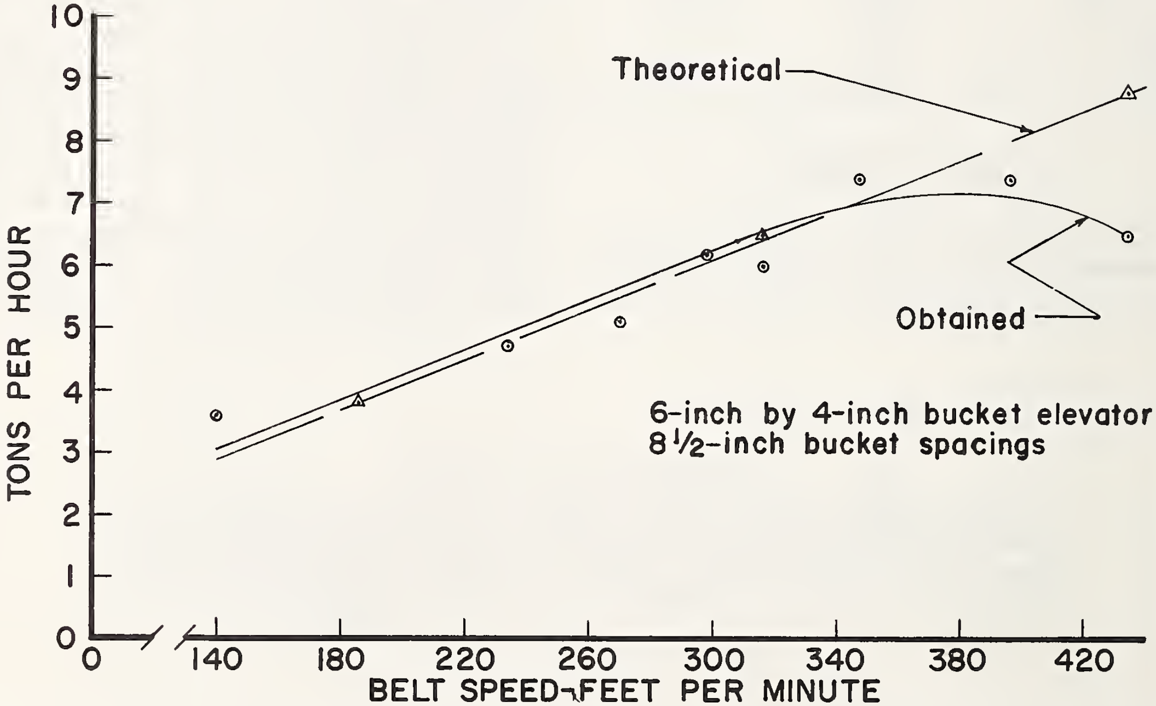

Figure 3.—Effect of belt speed on rate of conveying Spanish peanuts with small-bucket elevator, 8½-inch bucket spacing.

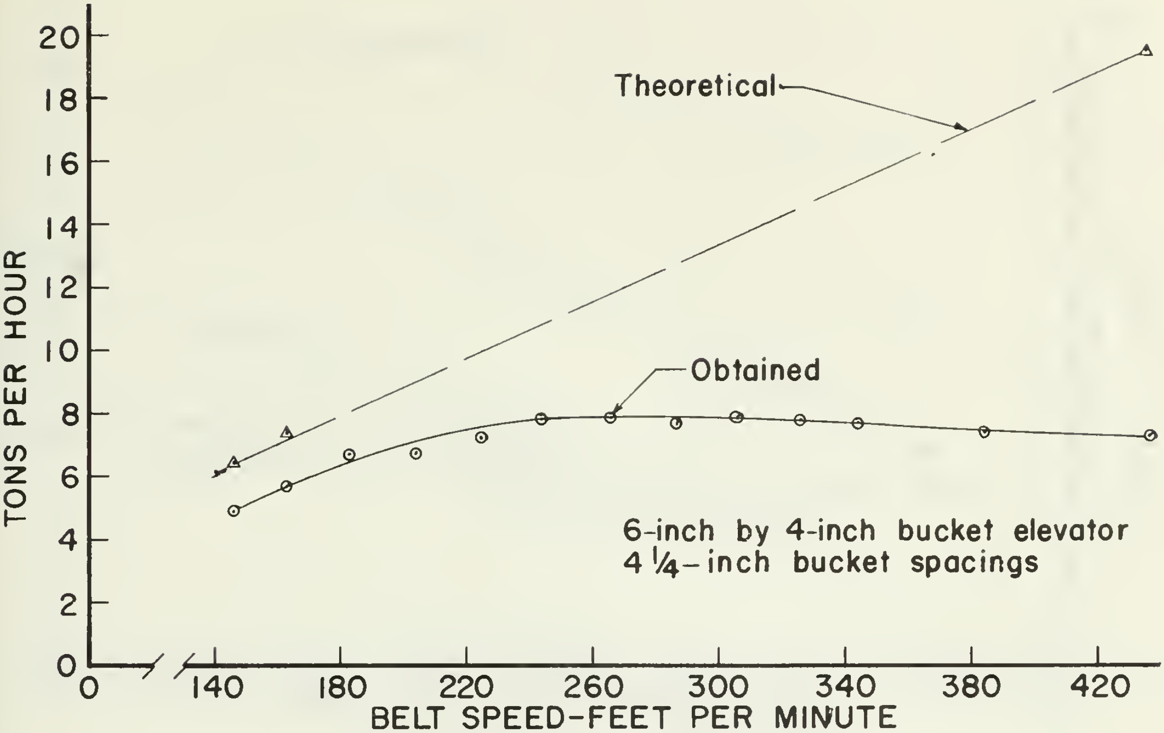

Figure 4.—Effect of belt speed on rate of conveying Runner peanuts with small-bucket elevator, 4¼-inch bucket spacing.

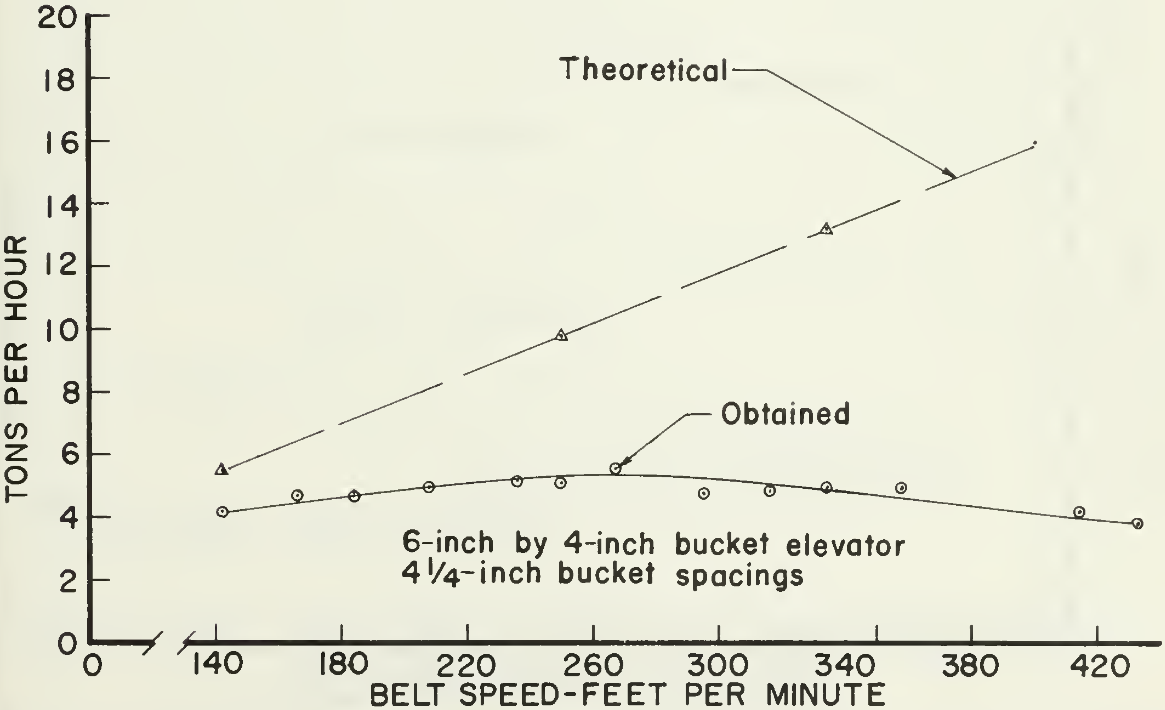

Figure 5.—Effect of belt speed on rate of conveying Virginia peanuts with small-bucket elevator, 4¼-inch bucket spacing.

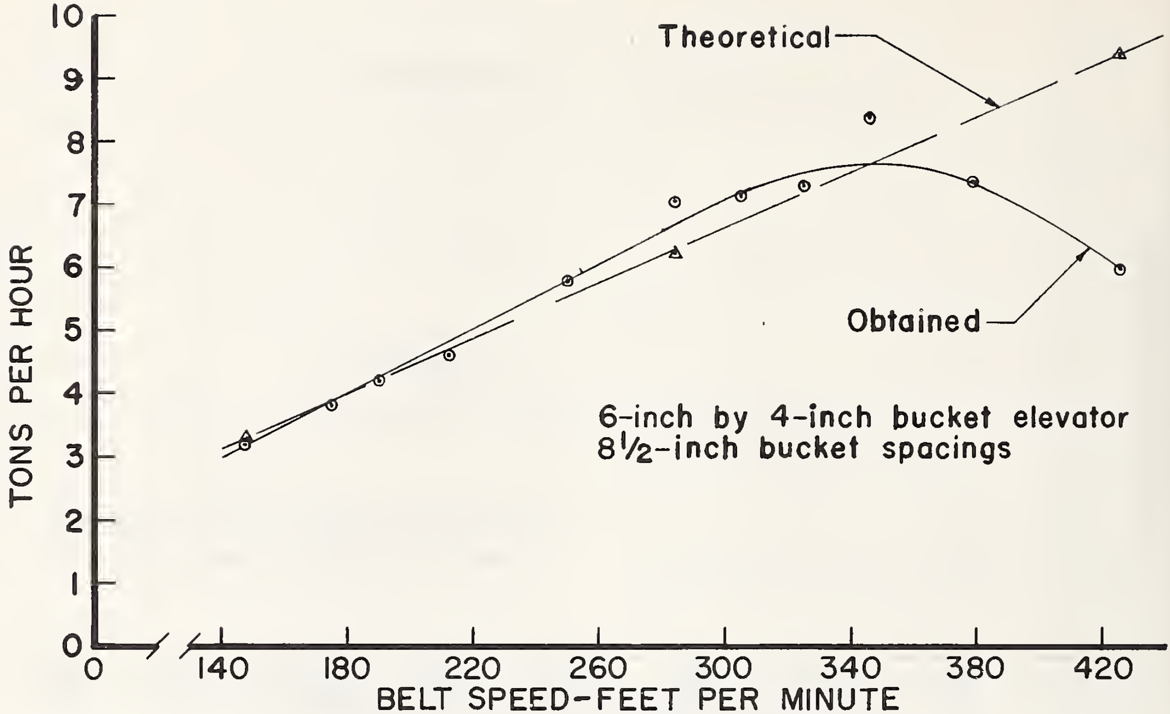

Figure 6.—Effect of belt speed on rate of conveying Runner peanuts with small-bucket elevator, 8½-inch bucket spacing.

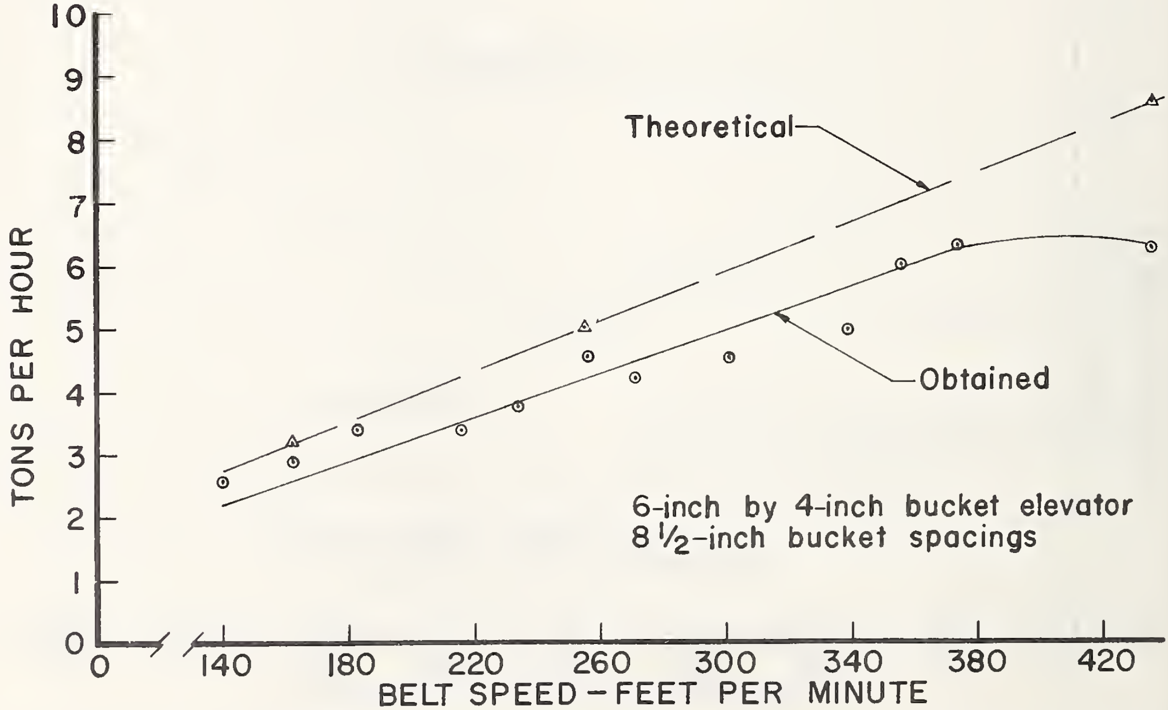

Figure 7.—Effect of belt speed on rate of conveying Virginia peanuts with small-bucket elevator, 8½-inch bucket spacing.

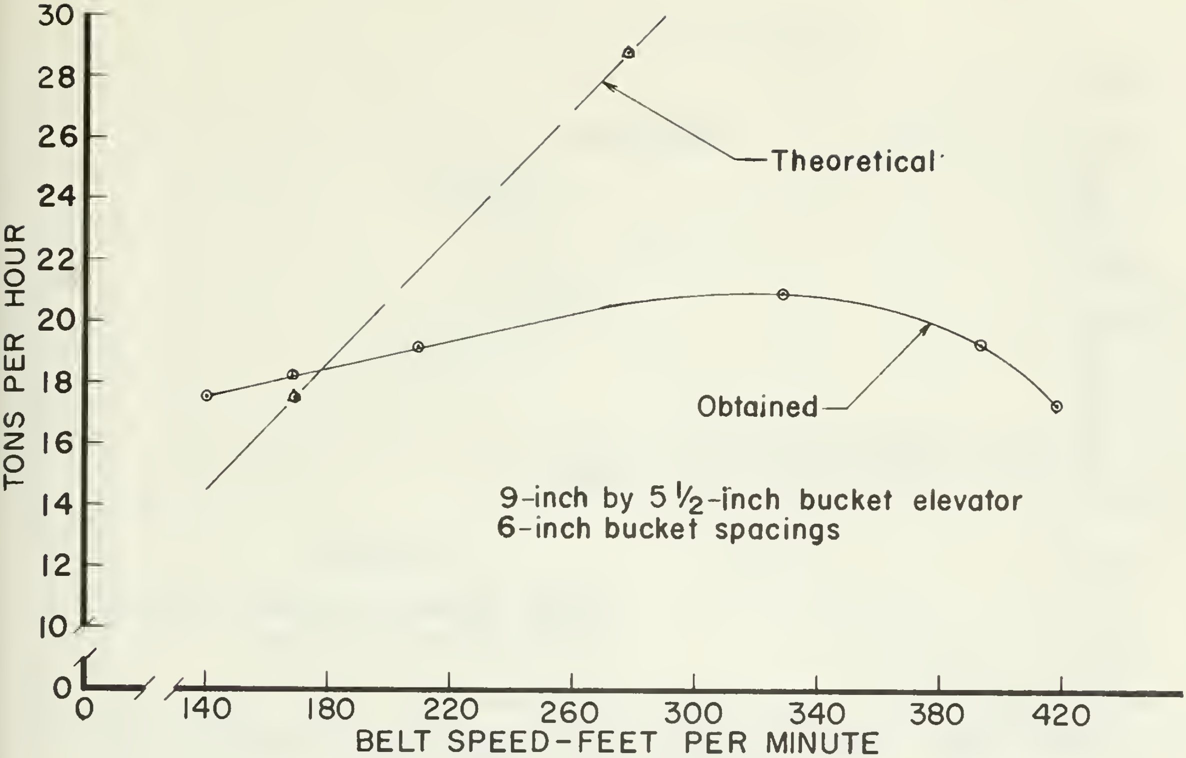

Figure 8.—Effect of belt speed on rate of conveying Spanish peanuts with large-bucket elevator, 6-inch bucket spacing.

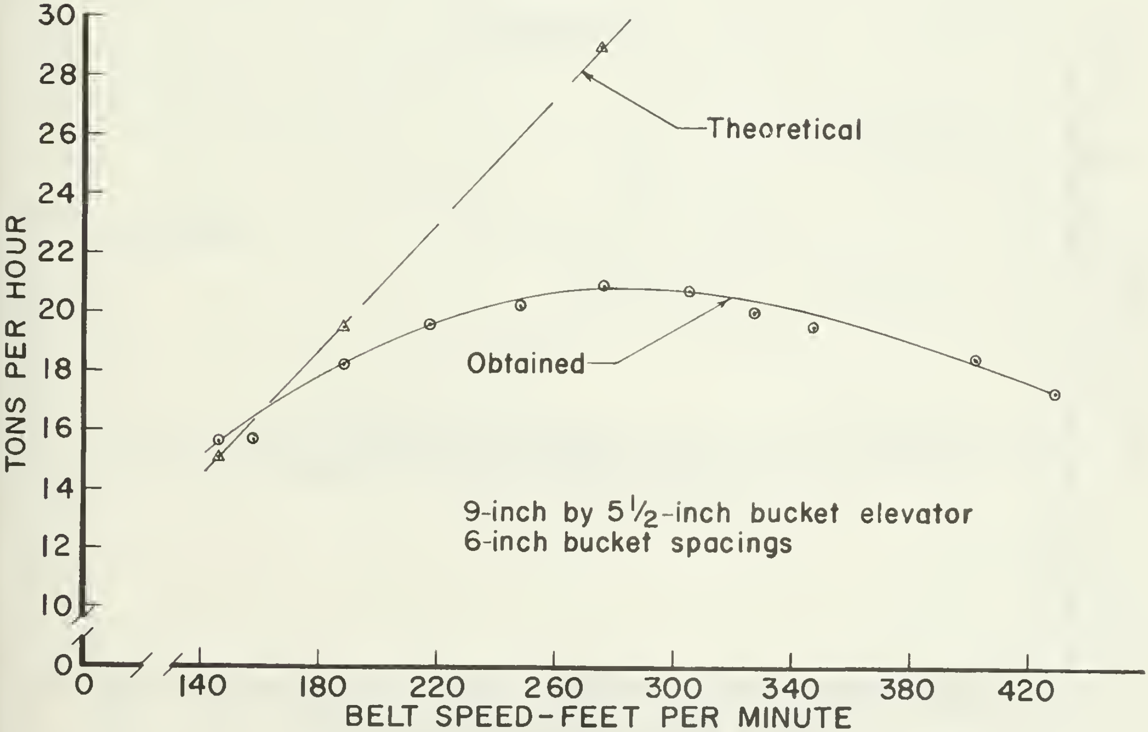

Figure 9.—Effect of belt speed on rate of conveying Runner peanuts with large-bucket elevator, 6-inch bucket spacing.

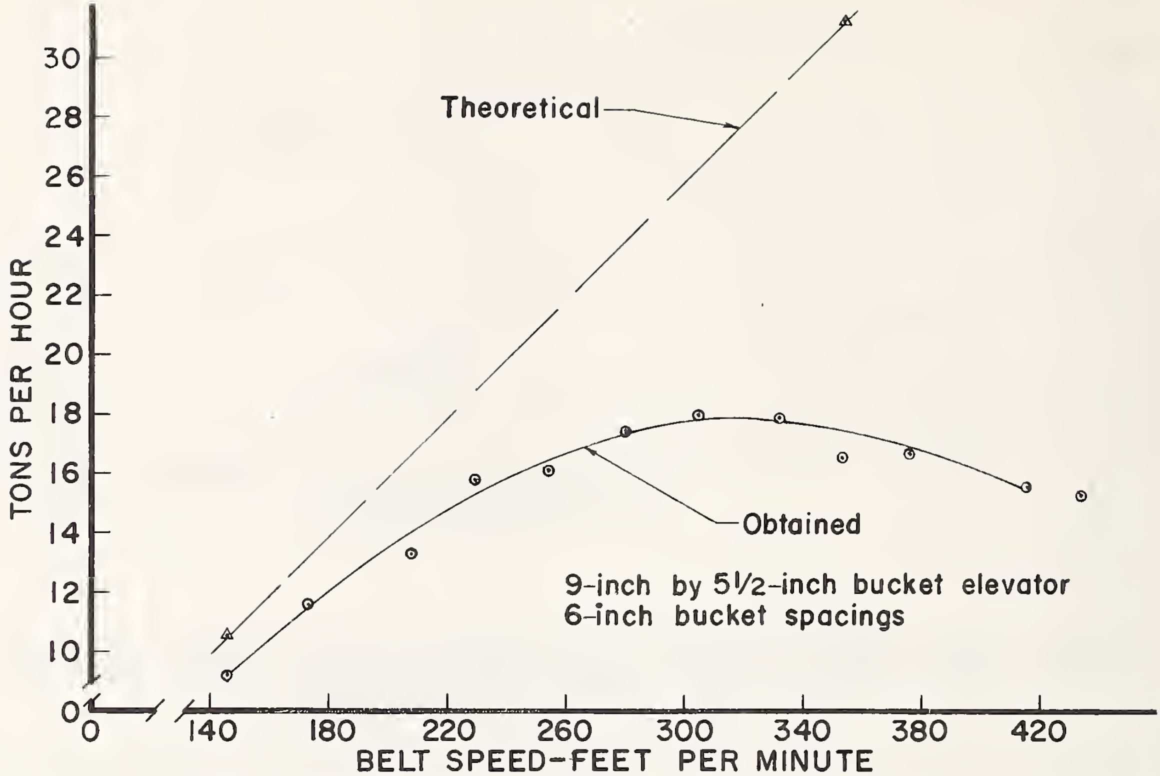

Figure 10.—Effect of belt speed on rate of conveying Virginia peanuts with large-bucket elevator, 6-inch bucket spacing.

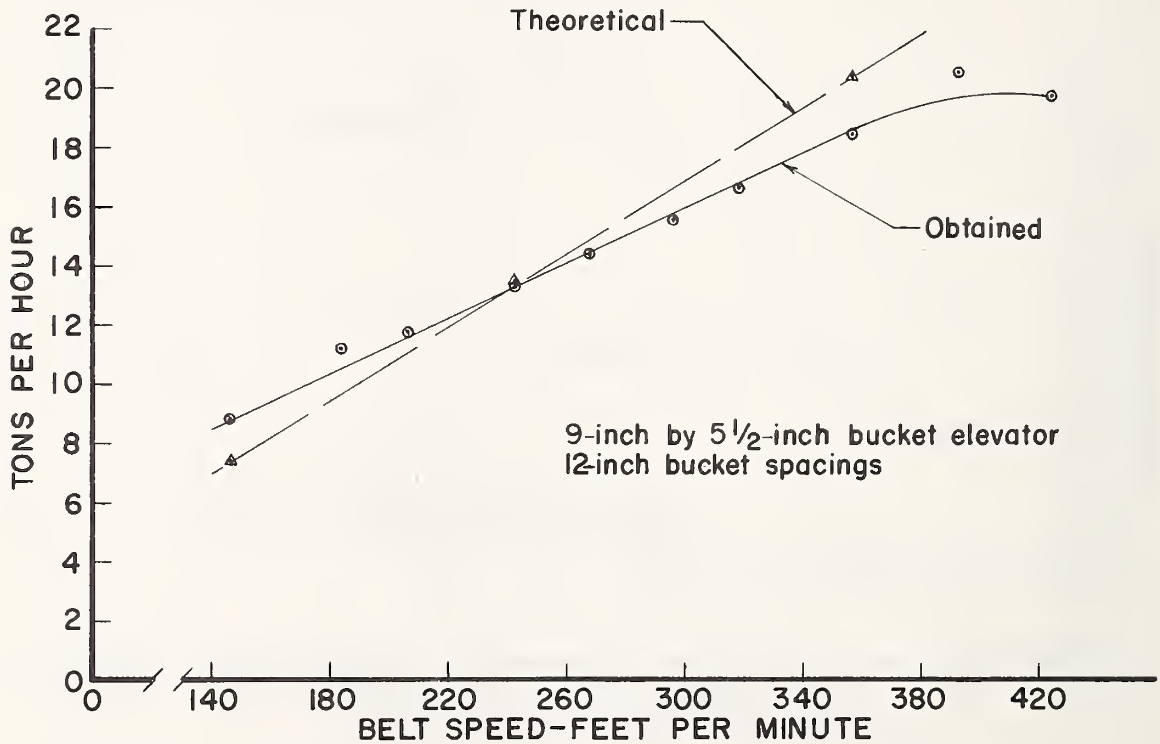

Figure 11.—Effect of belt speed on rate of conveying Spanish peanuts with large-bucket elevator, 12-inch bucket spacing.

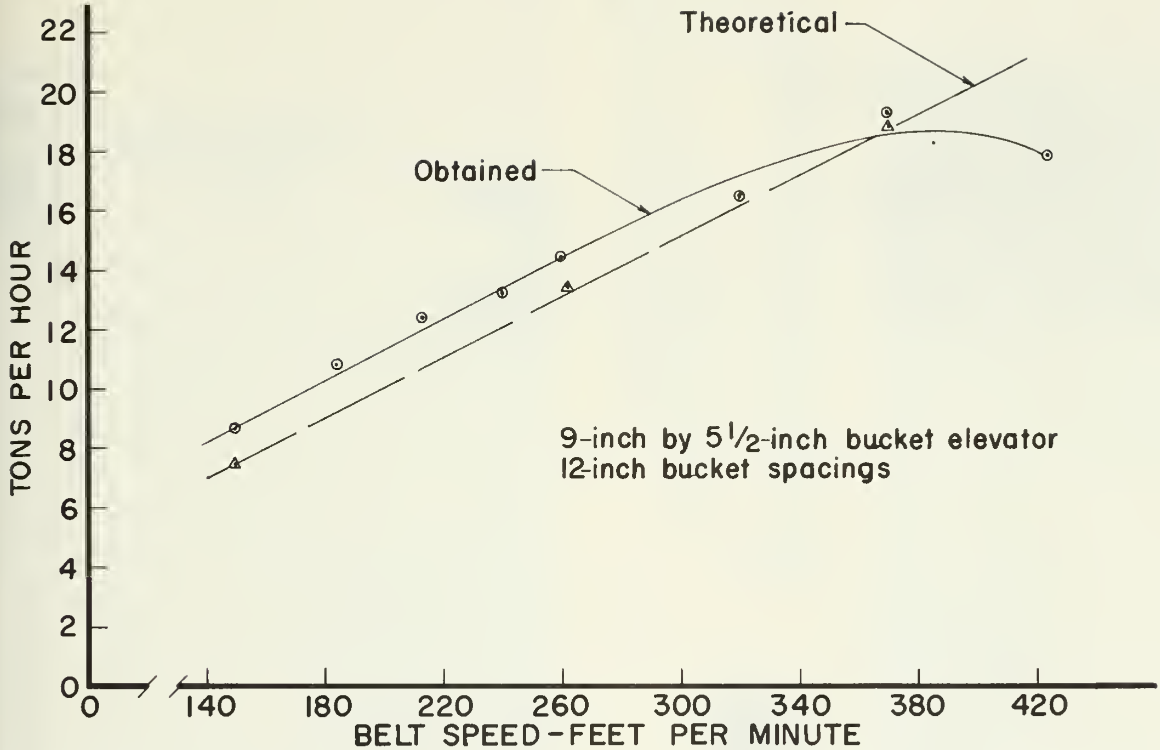

Figure 12.—Effect of belt speed on rate of conveying Runner peanuts with large-bucket elevator, 12-inch bucket spacing.

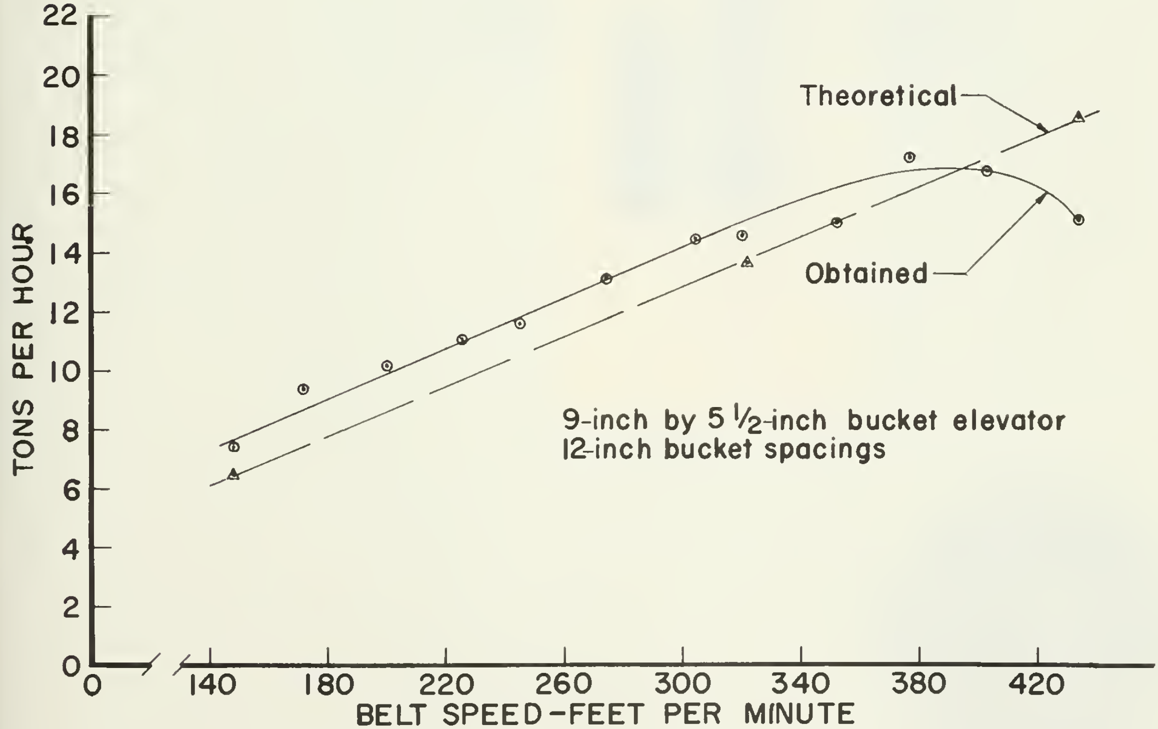

Figure 13.—Effect of belt speed on rate of conveying Virginia peanuts with large-bucket elevator, 12-inch bucket spacing.

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